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Case report

Proximal tibial replacement in revision knee arthroplasty for non-oncologic indications

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ABSTRACT

Proximal tibial metaphyseal bone loss compromises the alignment and fixation of components during revision total knee arthroplasty. In massive, segmental defects with loss of collateral ligamentous support and lack of bone to support the use of prosthetic augments or metaphyseal cones or sleeves, a hinged proximal tibial replacement or a so-called “megaprosthesis” should be available. While proximal tibial replacement is the reconstructive method of choice in the setting of bone tumor resection, applications in non-oncologic joint arthroplasty are rare and may offer an opportunity for limb salvage in dire clinical scenarios with massive proximal tibial bone loss. This report reviews 6 cases of proximal tibial replacement.

Introduction

The annual number of revision total knee arthroplasty (TKA) procedures in the United States is expected to climb from 38,300 in 2005 to 268,300 by 2030 [1,2]. Metaphyseal bone loss can result from stress shielding, osteolysis, osteonecrosis, fracture, infection, implant loosening, implant resection, or any combination of these and jeopardizes the alignment and fixation of components during revision TKA [3-6]. Selection of technique(s) to manage bone deficiency depends on the location, magnitude, containment of bone deficiency, ligament integrity, surgeon familiarity, and patient factors including functional expectations, probability of future revision, and overall health status [3,6-9].

In massive segmental Anderson Orthopedic Research Institute [10] type 3 defects with loss of collateral ligamentous support and lack of bone to support prosthetic augments or metaphyseal cones or sleeves, a hinged prosthesis, also termed a “megaprosthesis,” should be available. Distal femoral replacement (DFR) prostheses are readily used in these circumstances, but proximal tibial replacement (PTR) prostheses are used far less outside of oncologic applications. The indications are fewer, and reconstruction is more technically demanding because of proximity to neurovascular structures, poor supportive bone stock for fixation, concern for extensor mechanism preservation, and tenuous soft-tissue coverage. In addition, PTR prosthesis survivorship is poorer than DFR prosthesis survivorship, with mechanical failure including aseptic loosening, implant-related complications, extensor mechanism dysfunction, and infection as the main causes for removal [11-24].

Despite the technical demands and complications, PTR may offer an opportunity for limb salvage in dire non-oncologic clinical scenarios in revision knee arthroplasty with massive proximal tibial bone loss. This report reviews 6 cases of knee arthroplasty for non-oncologic indications where PTR was deemed appropriate.

The patients provided consent to use data and images related to their cases.

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Case histories

Case 1

Presentation

A 59-year-old female with morbid obesity (body mass index 43.9), fibromyalgia, obstructive sleep apnea, and lymphedema presented for treatment of her right knee after 4 prior arthroplasty procedures. She underwent bilateral primary TKA 10 years before. After 3 years, she presented with knee pain and instability. Radiographs demonstrated tibial loosening (Fig. 1a and b) and laboratory tests and aspiration were inconsistent with periprosthetic joint infection (PJI). She underwent revision to a constrained prosthesis. Five years later, the patient underwent another full revision for loosening of the femoral and tibial components (Fig. 1c-e). Inflammatory markers were normal. After 2 years, she presented with increasing activity-related pain, swelling, and instability. She was using a rolling walker. Examination revealed a draining wound distal to her incision overlying the proximal tibia. Radiographs demonstrated evidence of tibial component loosening (Fig. 1f-i). Erythrocyte sedimentation rate was normal while c-reactive protein was elevated (16.1 mg/L; range: 0-4.9). Aspiration showed negative alpha defensin, a cell count of 5426/uL with 80.7% neutrophils, and insufficient fluid for culture. The patient initially underwent resection arthroplasty with placement of a static antibiotic cement spacer (Fig. 2a and b). The surgeon noted a 10-cm uncontained segmental defect of the proximal medial tibia with an intact tibial tubercle. After 2 months and intravenous antibiotics, the patient had a persistent draining sinus despite the spacer.

Surgical intervention

The patient underwent spacer exchange (Fig. 2c) and simultaneous wound coverage, with a medial gastrocnemius flap incorporated into the distal arthrotomy closure by plastic surgery. Infectious disease consultation recommended 6 weeks of intravenous antibiotics. The knee incision healed completely.

Four months later, the patient underwent revision TKA (Fig. 3). The flap was elevated as part of a medial parapatellar arthrotomy. The smallest available Biomet OSS (Zimmer Biomet, Warsaw, IN) PTR prosthesis in the anteroposterior plane was chosen (9 cm $\times$ 51 mm modular RS) to accommodate retention of the intact tibial tubercle and anterolateral tibial cortex. The tibial canal was reamed, and a burr was used to prepare the proximal diaphysis rather than a facing reamer to avoid disrupting the tubercle. An 11 $\times$ 225-mm cemented stem was selected to bypass a distal third diaphyseal lateral cortical defect. The tubercle was secured to the prosthesis using two 18-gauge wires. On the femoral side, the Biomet OSS 3-cm standard DFR prosthesis was used with a small OsteoTi (Zimmer Biomet, Warsaw, IN) metaphyseal sleeve augment and a cemented 90-mm stem.

Figure 1. Case 1 preoperative radiographs. From top left, clockwise: (a, b) primary TKA complicated by tibial component loosening, (c-e) revision to rotating platform constrained prosthesis, with evidence of tibial loosening, (f-i) second revision complicated by tibial component subsidence and infection.

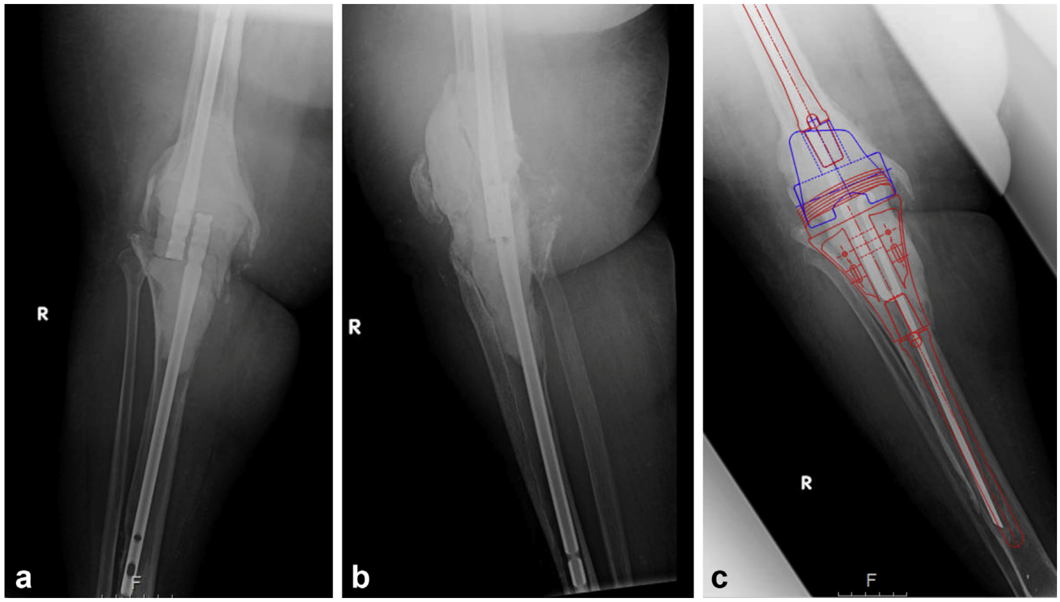

Figure 2. Case 1 preoperative radiographs. From left to right: (a, b) anteroposterior and lateral radiographs of static antibiotic cement spacer, (c) template for proximal tibial and distal femoral replacement components after spacer exchange.

Postoperative course

The patient was toe touch weight bearing in a knee immobilizer for 2 weeks. The immobilizer was discontinued, and she was advanced to weight bearing as tolerated. Her incision healed without complication. Infectious disease recommended long-term prophylactic oral antibiotic therapy (doxycycline). Her lymphedema was treated with compression wrapping techniques. At the latest follow-up visit (1.5 year after operation), she is pain-free and ambulating unassisted (Fig. 4). Active range of motion is 0 to 90 degrees without extensor lag.

Case 2

Presentation

A 72-year-old female with psoriatic arthritis off biologics presented for treatment of her right knee after 3 prior arthroplasty

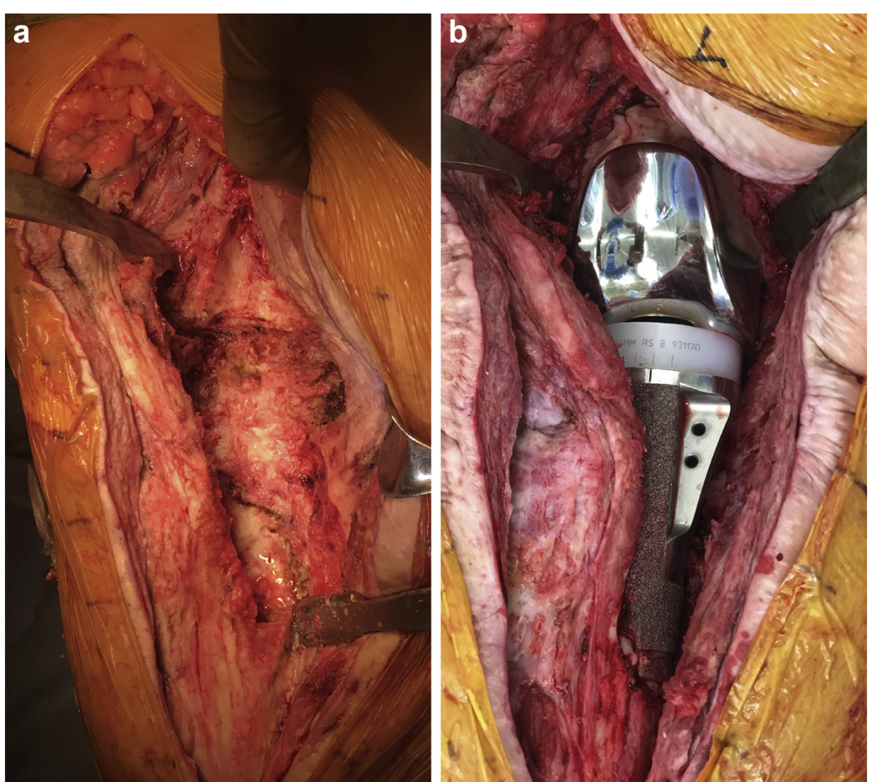

Figure 3. Case 1 intraoperative images. From left to right: (a) after removal of spacer demonstrating extensive medial tibial bone loss, (b) final component implantation.

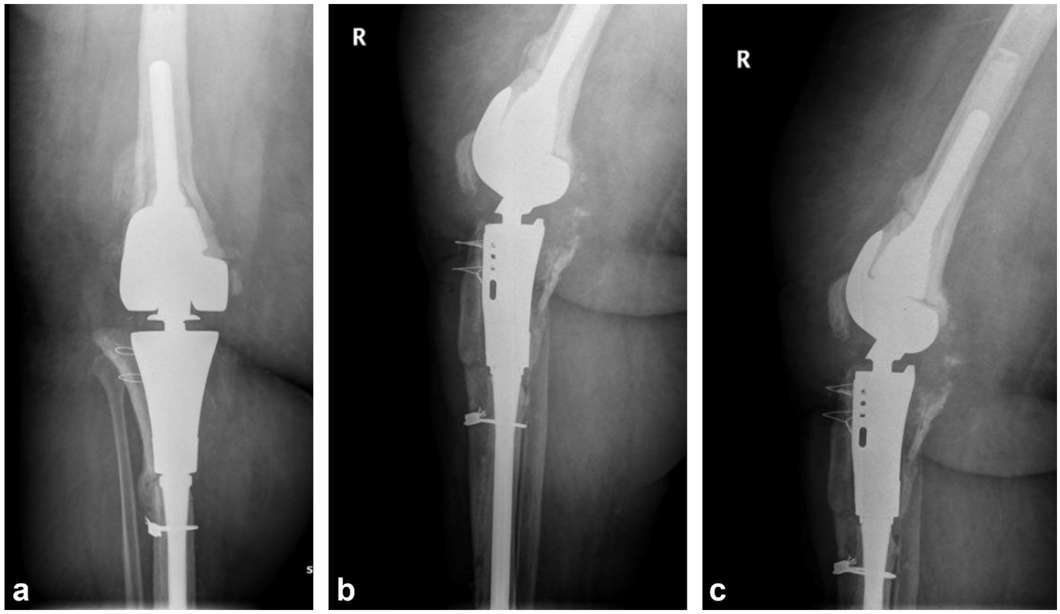

Figure 4. Case 1 at 1 y postoperative. From left to right: (a-c) Anteroposterior and lateral radiographs show stable components. The tibial tubercle demonstrates healing with the diaphysis and integration with the PTR.

Figure 5. Case 2 preoperative radiographs. From top left, clockwise: (a-e) Radiographs show a distal femoral replacement and a tibial component with metaphyseal cone. There is evidence of mechanical failure of the tibial component which proximally has shifted into varus with a well-fixed cemented stem distally. Patellar bone stock is deficient.

procedures. She underwent primary TKA 20 years before, complicated by PJI 10 years postoperatively which was treated with 2-stage revision. Reconstruction required a DFR and large tibial metaphyseal cone presumed secondary to bone loss. She remained on dicloxacillin long-term prophylactic antibiotic therapy when she presented with debilitating, activity-related, proximal tibial pain. She was ambulatory with a rolling walker. Examination demonstrated a well-healed incision without signs of infection and functional extensor mechanism. Radiographs demonstrated poor patellar bone stock and apparent mechanical failure of the tibial component, the proximal portion of which was in varus alignment while the cemented stem appeared well fixed (Fig. 5). There was significant bone loss at the proximal medial tibia. Regarding the DFR, the proximal femoral stem was in contact with the lateral cortex of the femur, which was stable from prior radiographs without surrounding lucency to suggest loosening. Aspiration yielded negative alpha defensin, 607 WBC/uL, 19.5% neutrophils, and a negative culture.

Surgical intervention

The patient underwent revision TKA. Upon exposure, there was diffuse metallosis (Fig. 6). The tibial construct was disrupted at the modular junction between the baseplate and stem. The proximal segment, including the baseplate and cone, was manually removed. The threaded proximal end of the stem was stripped, and appeared to be the source of metallosis. There was uncontained segmental bone loss of the entire medial proximal tibia extending to the diaphysis, with intact anterolateral cortex and tibial tubercle. The distal stem remained well fixed within a robust cement mantle despite attempts at removal from above. A tibial tubercle osteotomy was extended 12 centimeters distally and hinged on the lateral cortex. The exposed stem and cement mantle were disrupted using a pencil-tip burr and removed. Approximately 1 cm of bone was carefully dissected from the posterior soft tissues and removed to provide adequate resection for PTR. A burr was used to prepare the proximal tibia rather than a facing reamer. Three 18-gauge wires were passed through drill holes into the tibial canal to be passed around the implanted stem and secured over the reduced osteotomized tibia. A small-size Global Modular Replacement System (GMRS) prosthesis was inserted with an 11 × 127-mm stem (Stryker, Inc, Kalamazoo, MI). The tibial component was cemented. Final tightening of the wires provided pressurization of the cement and reduction of the tubercle fragment. The osteotomy repair remained stable at 90 degrees of knee flexion.

Postoperative course

The patient was toe touch weight bearing in a knee immobilizer for 2 weeks. The immobilizer was discontinued, and she was advanced to 50% weight-bearing, and then to weight bearing as tolerated at 6 weeks. Infectious disease recommended resumption of long-term antibiotic therapy (dicloxacillin). At 8 weeks after surgery, she developed wound breakdown at the distal extent of the incision overlying the tibial wires requiring irrigation and debridement and medial gastrocnemius flap. At the latest follow-up visit (1 year after operation), her knee is pain-free, and she ambulates with the help of a walker (Fig. 7). She has global bodily pains and functional deficits related to poorly controlled inflammatory arthritis. The skin is completely healed. Active range of motion is 5 to 110 degrees, with 5 degrees of extensor lag.

Case 3

Presentation

A 65-year-old male with neurofibromatosis, chronic obstructive pulmonary disease, heart failure, obstructive sleep apnea, anemia, and osteoporosis presented with left knee pain and instability after a proximal tibial fracture treated with open reduction internal fixation 2 years before. Before his fracture, he reported a foot drop but independent ambulation in a knee ankle foot orthosis. After his fracture, he did not resume independent ambulation. Examination

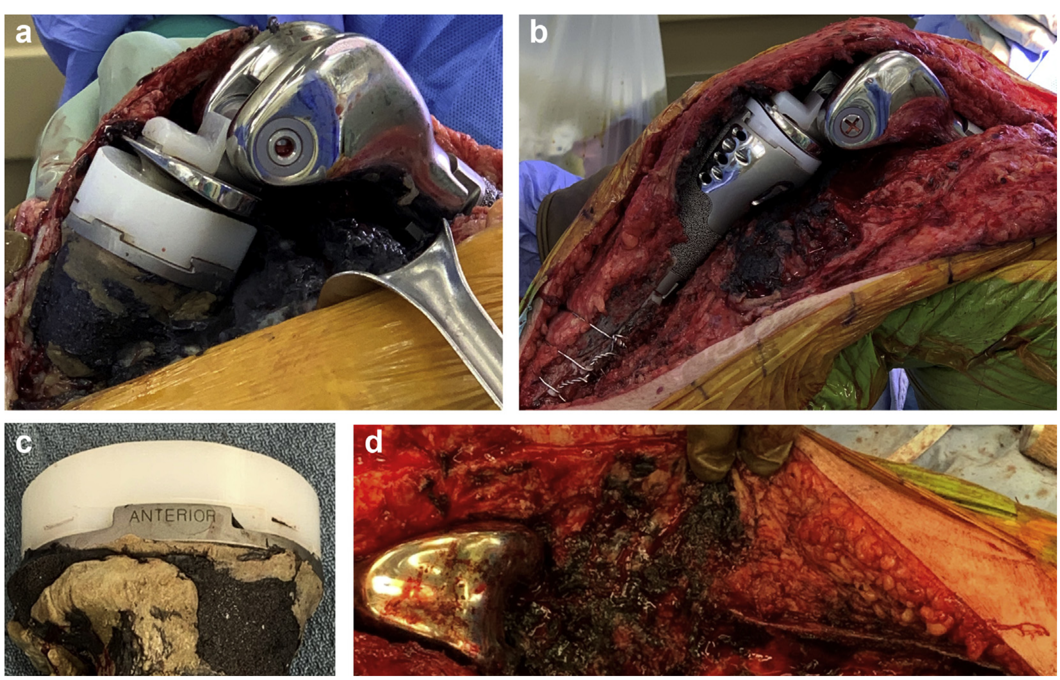

Figure 6. Case 2 intraoperative images. From top left, counterclockwise: (a) diffuse metallosis, (b) the tibial construct was disrupted between the modular junction of the baseplate and stem, (c) after tibial tubercle osteotomy and stem removal, image shows a massive uncontained segmental bone defect of the medial proximal tibia extending to the diaphysis. The tibial tubercle is hinged on the lateral cortex in continuity with the lateral soft tissues. (d) Proximal tibial replacement in place. Eighteen-gauge wires secure the osteotomized bone.

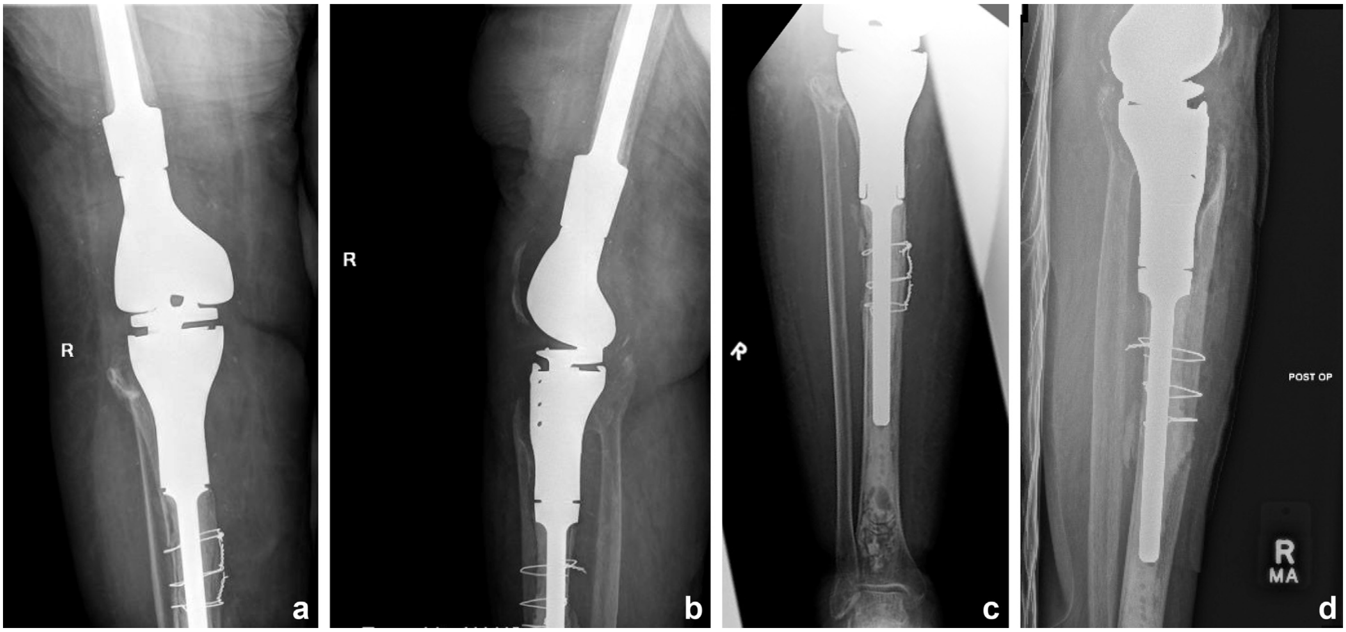

Figure 7. Case 2 at 3 mo postoperative. From left to right: (a-d) Radiographs show stable appearance of the cemented tibial component and tibial osteotomy.

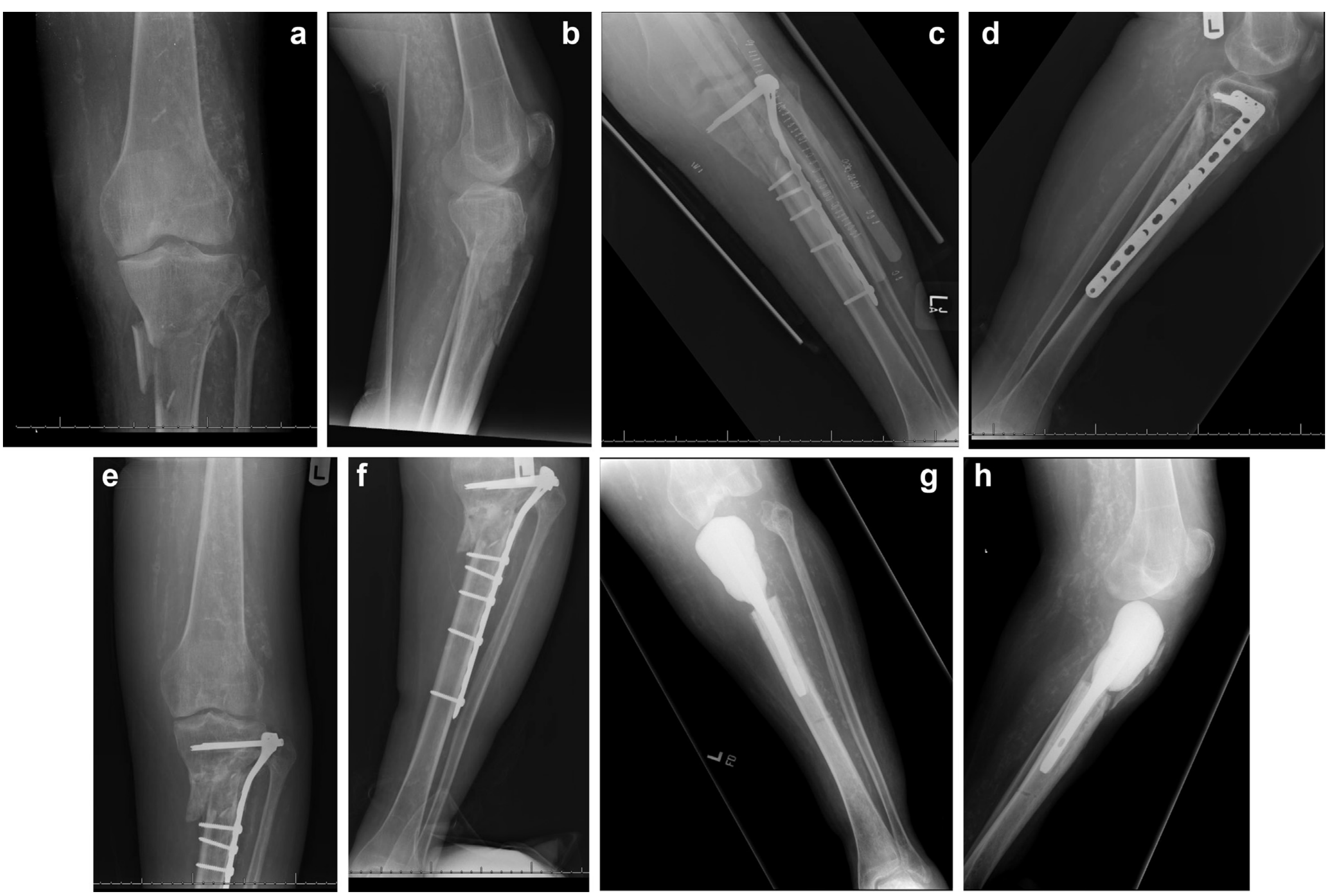

Figure 8. Case 3 preoperative radiographs. From top left, clockwise: (a, b) Injury radiographs show a comminuted proximal tibial metaphyseal-diaphyseal fracture. Note the posterior soft-tissue calcification, representing a large plexiform neuroma. (c, d) Radiographs after open reduction internal fixation show appropriate alignment of the fracture. (e, f) Follow-up radiographs show fracture nonunion, displacement, and hardware failure. (g, h) Radiographs show removal of proximal tibial fragment and presence of antibiotic spacer after purulent material was found in the tibial canal.

demonstrated gross motion through his fracture site. Radiographs and computed tomography showed atrophic nonunion with hardware loosening and a calcified mass along his posterior leg consistent with a plexiform neurofibroma (Fig. 8). Inflammatory markers were normal. However, after hardware removal and proximal tibia resection, the surgeon encountered purulent fluid in the tibial canal. Cultures and pathology were sent, and an antibiotic spacer was placed. One culture grew coagulase negative *Staphylococcus*. Infectious disease recommended intravenous daptomycin for 6 weeks. Subsequently, knee aspirate and inflammatory markers normalized.

Surgical intervention

Three months later, the patient underwent reconstruction. The patellar tendon was elevated as part of a lateral soft-tissue sleeve. The spacer was removed. The tibial canal was reamed, and the proximal tibia was prepared with a facing reamer. The PTR was assembled with a 13 × 150-mm GMRS stem (Stryker, Inc, Kalamazoo, MI). The femoral component used a 19 × 80-mm stem. All components were cemented. The extensor mechanism was repaired using 3 rows of FiberWire (Arthrex, Inc, Naples, FL) through the patellar tendon and through suture holes in the tibial implant.

Postoperative course

The patient was weight bearing as tolerated in a knee immobilizer. At 2 weeks, radiographs showed patella alta. The immobilizer was used until 6 weeks, and he had no extensor lag. At 3 months, he weaned from his hinged brace. At 6 months, he had no extensor lag and was ambulating with the help of a walker. However, at 5 years after operation, he presented with recurrent knee buckling and a palpable defect over his patellar tendon. He had an extensor lag of 30 degrees. He opted for nonoperative management and ambulated in a hinged brace locked in extension. At the latest follow-up visit (6 years after operation), he was primarily using a wheelchair, in part due to bilateral rotator cuff arthropathy, and could no longer extend his knee against gravity. He remained pain-free and elected to continue nonoperative management (Fig. 9).

Case 4

Presentation

A 60-year-old female with obsessive compulsive disorder and current cigarette use presented with a painful left knee after 4 prior arthroplasty procedures. Her primary TKA 3 years earlier was complicated by quadriceps tendon rupture that happened postoperatively at 6 months. The surgeon found purulence on attempted repair, and she underwent 2-stage revision. She was on long-term doxycycline. Five months after reimplantation, she experienced a low-energy knee dislocation which remained unstable after reduction. She underwent revision to a hinged prosthesis (Fig. 10). She then presented with pain. She remained independently ambulatory. Her extensor mechanism was functional but with lateral subluxation of the patella. Radiographs demonstrated tibial component loosening with progressive metaphyseal and diaphyseal osteolysis and impending fracture at the distal aspect of the tibial stem. Laboratory tests and aspiration were consistent with recurrent PJI. Bacterial and fungal polymerase chain reaction sequencing was negative for all organisms on level 1 testing, but level 2 testing showed *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Pseudomonas acnes*, *Staphylococcus epidermidis*, and multiple other organisms. A second opinion recommended amputation. The patient opted for 2-stage revision and eventual PTR to attempt limb salvage. She completed a course of vancomycin. She required spacer exchange at 2 months postoperatively after a fall that resulted in perforation of the anterior distal femoral cortex and medial femoral condyle fracture (Fig. 11). Intraoperative cultures were negative. Subsequent aspiration was dry. Inflammatory markers were slightly elevated but trended downward.

Surgical intervention

Five months later, the patient underwent reimplantation with a PTR. The spacer was removed. The extensor mechanism was in continuity with severe bone loss on both the tibial and femoral sides. A small-size GMRS (Stryker, Inc, Kalamazoo, MI) was used with an 11 × 127-mm cemented stem. For the femur, a 40-mm DFR with an 11 × 127-mm cemented stem was used.

Postoperative course

The patient was in a knee immobilizer for 2 weeks. Her incision healed without complication. At 2 months, she was prescribed a custom hinged knee brace with a spring-loaded hyperextension assist and a 40-degree extension block because of symptomatic buckling that was interfering with ambulation. At the latest follow-up visit (2 years after operation), she reported minimal knee pain and was ambulating with the help of a walker (Fig. 12). She had a 40-degree extensor lag.

Figure 9. Case 3 at 6 y Postoperative. From left to right: (a) patella alta seen on radiographs corresponded with patient's progressive extensor mechanism dysfunction. (b-e) Radiographs show well-fixed femoral and proximal tibial replacement components without signs of loosening.

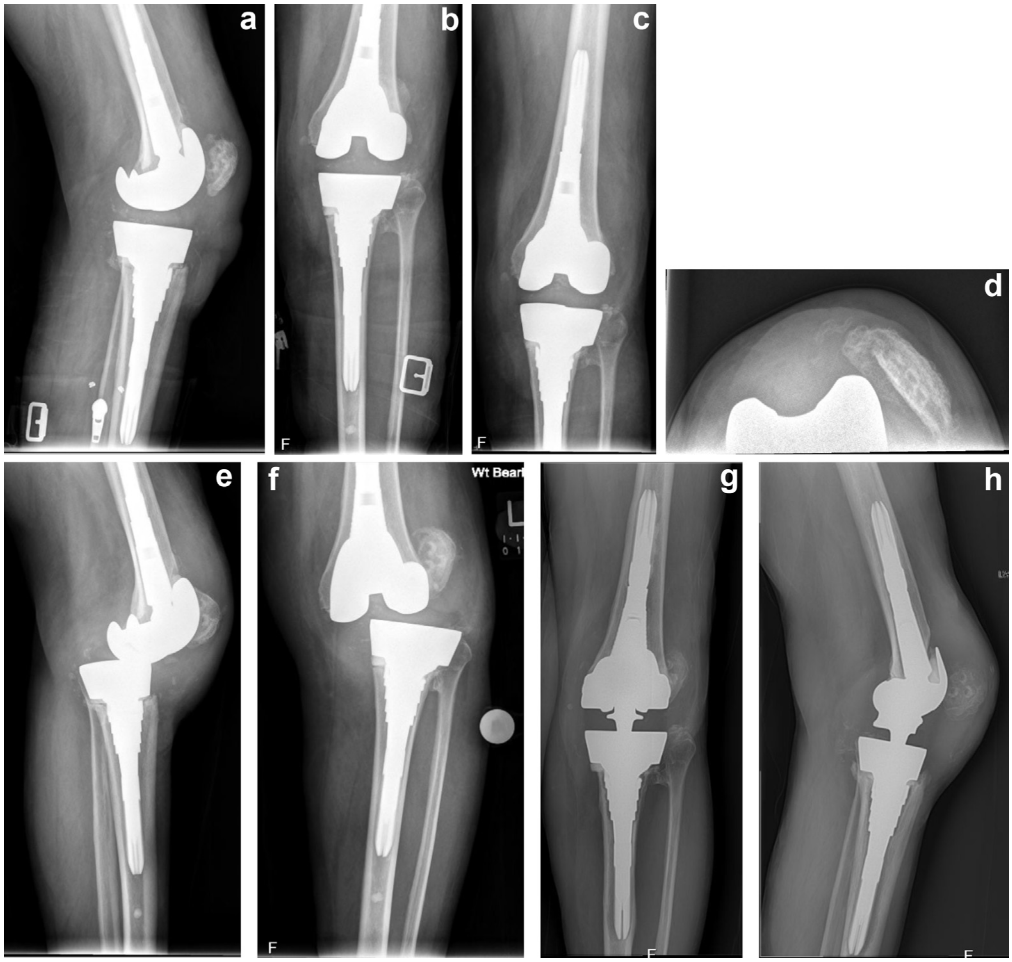

Figure 10. Case 4 preoperative radiographs. From top left, clockwise: (a-d) revision components after resection arthroplasty and spacer due to infection; note lateral dislocation of the patella, consistent with patient's clinical extensor mechanism dysfunction (d). (e, f) Radiographs show posterolateral knee dislocation. (g, h) Radiographs after revision to hinged prosthesis. Osteolysis is present around the tibial stem metaphysis and diaphysis.

Case 5

Presentation

An 83-year-old female with type 2 diabetes, obesity (body mass index 41), and prior abdominal methicillin-resistant *Staphylococcus aureus infection* presented with worsening right knee pain and instability 20 years after primary TKA. Examination demonstrated a 30-degree extensor lag, gross laxity to varus and valgus stress, and a well-healed incision. She used a motorized scooter because of pain. Radiographs showed loosening of the tibial component with proximal tibial osteolysis and lucency around the tibial tubercle, as well as around the femoral component (Fig. 13). Aspiration was negative for infection. Revision surgery was recommended but delayed because of other health issues, including a rectovaginal fistula and recurrent urinary tract infections. Once medically stable, she was unable to extend her knee against gravity and had 20 degrees of passive extension and 60 degrees of passive flexion. Erythrocyte sedimentation rate was 44 mm/h and c-reactive protein 16.6 mg/L. Knee aspiration showed a cell count of 7200/uL, negative leukocyte esterase, and negative cultures.

Surgical intervention

Intraoperative samples sent to pathology showed 2 white blood cells per high-powered field. The surgeon proceeded with revision. The tibial and femoral implants were grossly loose and easily removed. The tibial tubercle was dissociated from the tibia, and there was severe posteromedial bone loss extending to the diaphysis. The tibia was cut 95 mm distal to the joint line. Implants included Stryker MRH femoral component with an 80-mm cemented stem and Stryker GMRS small-size PTR component with a 9 $\times$ 127-mm cemented stem (Stryker, Inc, Kalamazoo, MI). A wafer of tibial tubercle was contoured to the anterior, porous, coated PTR and sutured in place with #5 Ethibond (Johnson & Johnson, New Brunswick, NJ) Krackow stitches. An additional stitch through 2 drill holes in the tibial tubercle was secured through a hole on the anterior aspect of the tibial prothesis.

Postoperative course

The patient was non–weight-bearing in a knee immobilizer, but at 6 weeks, she presented with her knee flexed to 40 degrees and admitted noncompliance. Her incision healed without complication. Radiographs showed 1.5-cm proximal migration of the tibial tubercle. She was advanced to toe touch weight bearing. At 10 weeks, she had a 30-degree extensor lag. She was advanced to weight bearing as tolerated with a hinged knee brace in full extension extension and permitted to progressively increase her flexion when not weight bearing. At the latest follow-up visit (4 years after operation), the patient had no pain or signs of infection (Fig. 14). She was ambulating in a custom hinged knee brace locked-in extension for transfers and short distances and otherwise in a

Figure 11. Case 4 preoperative radiographs continued. From top left, clockwise: (a-d) Radiographs shows progressive osteolysis around the tibial component with impending lateral diaphyseal fracture. There is also osteolysis and loosening of the femoral component. (e) Initial radiographs after explantation and static antibiotic spacer placement. (f, g) Subsequent radiographs show medial femoral condyle fracture with spacer perforation of the anterior femoral cortex. (h-j) Radiographs show revision static spacer using knee arthrodesis implant. Note the large region of bone loss and osteolysis in the proximal tibia and tibial diaphysis.

wheelchair. She had a 45-degree extensor lag. She passed away at 4.5 years after surgery.

Case 6

Presentation

An 84-year-old female with anemia, glaucoma, hypothyroidism, osteoporosis, and bilateral TKA (2002) was transferred for management 1 month after sustaining an open right periprosthetic tibia fracture in a motor vehicle accident. The referring center had performed irrigation, debridement, tibial component resection, placement of an antibiotic cement ball, and knee-spanning external fixation (Fig. 15). The patient complained of pain and presented using a wheel chair. Her incision was healed. Two-stage revision was planned. The retained femoral and patellar components and cement spacer were removed. The tibial tubercle was a free fragment attached to the patellar tendon. The lateral soft tissues were elevated as a unit. The tibial shaft was cut to prepare for eventual PTR. The femoral and tibial canals were reamed and irrigated, and a static antibiotic cement spacer was placed (Fig. 16). Intraoperative cultures grew methicillin-resistant *Staphylococcus epidermidis.* The patient completed a course of vancomycin.

Surgical intervention

Three months later, the patient underwent reimplantation. A femoral peel was performed for exposure. The spacer was removed. The canals were reamed. The DePuy PTR implant was used (DePuy Synthes, Warsaw, IN). The tibial tubercle was scarred in lateral soft tissues and required dissection for mobilization. A reverse V-Y turndown was performed. A lateral release was performed. The implants were cemented. Three drill holes were made in the tubercle fragment, and #5 Ethibond sutures were passed through the PTR to secure the tubercle to the prosthesis under tension. The extensor mechanism remained stable to 40 degrees of flexion.

Postoperative course

The patient was weight bearing as tolerated in a knee immobilizer for 2 weeks. Her incision healed without complication. Range of motion was increased to 30 degrees in a hinged brace then increased by 10 degrees weekly. At the latest follow-up visit

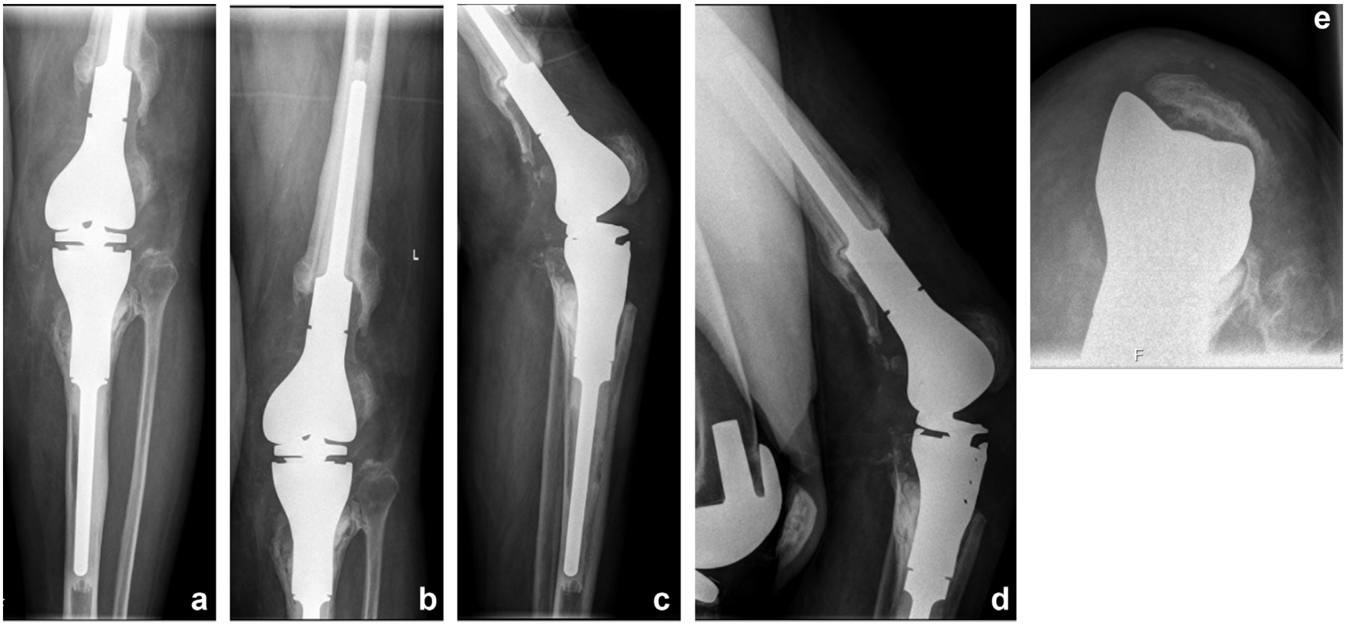

Figure 12. Case 4 at 2 y postoperative. From left to right: (a-d) Radiographs showing well-fixed cemented distal femoral and proximal tibial replacement components. (e) Radiograph showing the patella centered in the trochlea of the femoral component.

(2 years after operation), she has no knee pain and ambulates with the help of a walker, which she attributes in part to pain in her contralateral ankle from a pilon fracture (Fig. 17). She can climb and descend stairs. She has passive motion from 0 to 115 degrees with a 20-degree extensor lag.

Discussion

In the setting of massive segmental defects of the proximal tibia with loss of collateral ligamentous support and lack of bone to support prosthetic augments or metaphyseal cones or sleeves, a

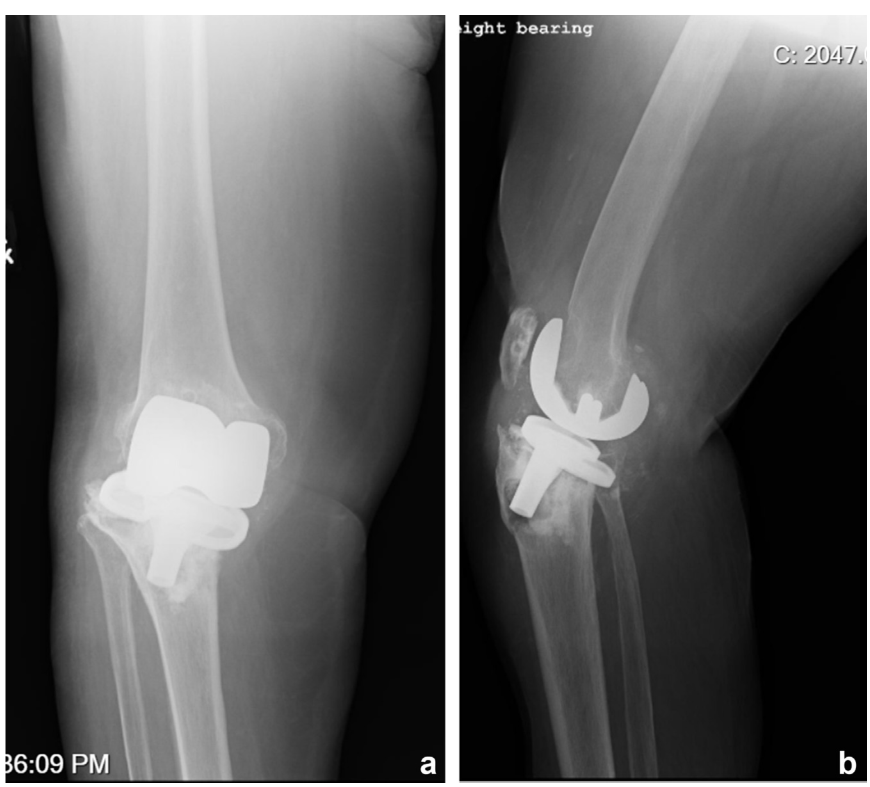

Figure 13. Case 5 preoperative radiographs. From left to right: (a, b) Anteroposterior and lateral radiographs show primary TKA components with varus collapse of the tibial component, significant proximal tibial osteolysis, and lucency around the femoral component.

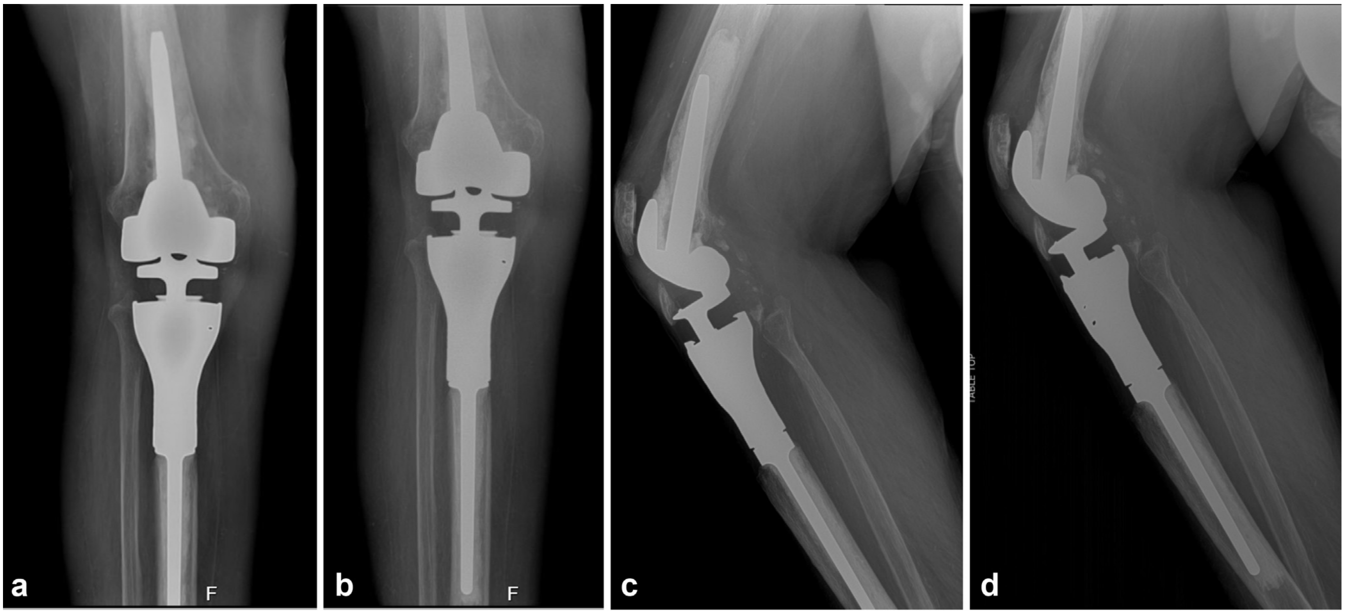

Figure 14. Case 5 at 4 y postoperative. From left to right: (a, b) Anteroposterior radiographs show well-fixed femoral and proximal tibial replacement components. (c, d) Lateral radiographs show patella alta and proximal migration of the tibial tubercle fragment which had been suture repaired to the prosthesis at the time of surgery.

PTR hinged prosthesis may create the most biomechanically stable construct. We present 6 cases of PTR in revision knee arthroplasty for non-oncologic indications. Overall, follow-up ranged from 1.5 to 6 years. No further revision surgery was performed in any case, and thus all PTR components remain implanted with the exception of one patient who passed away. PTR reliably achieved limb salvage

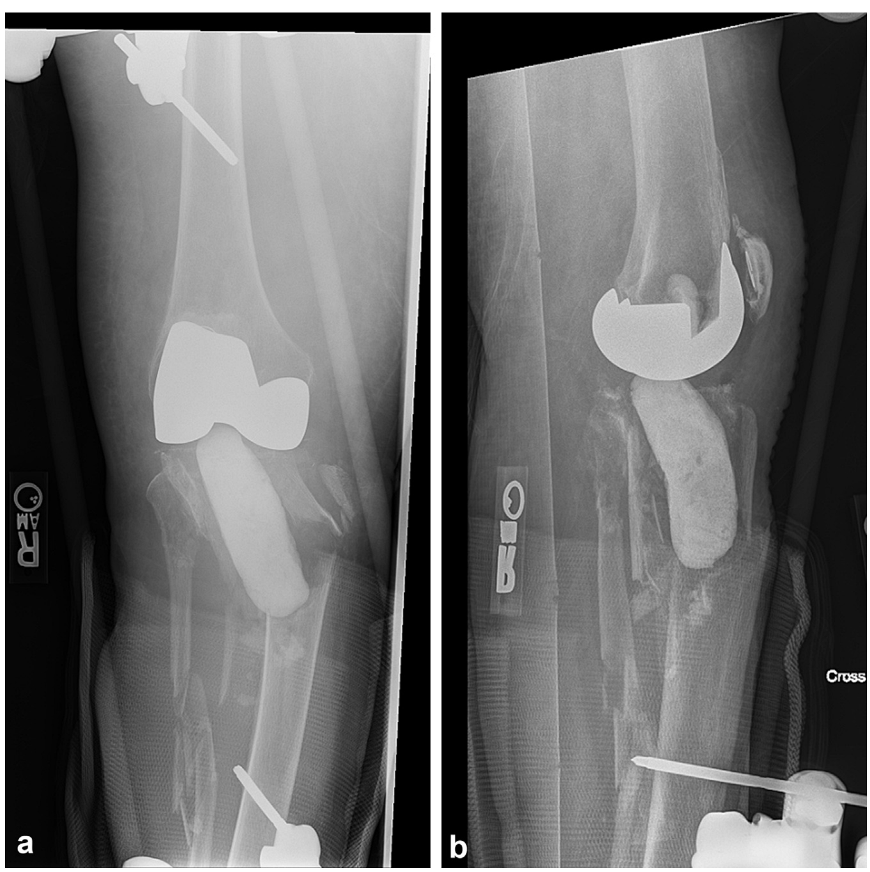

Figure 15. Case 6 initial presentation radiographs. From left to right: (a, b) Anteroposterior and lateral radiographs show comminuted proximal tibia and fibula fractures with cement spacer in the proximal tibia, knee-spanning external fixator in place and retained femoral component.

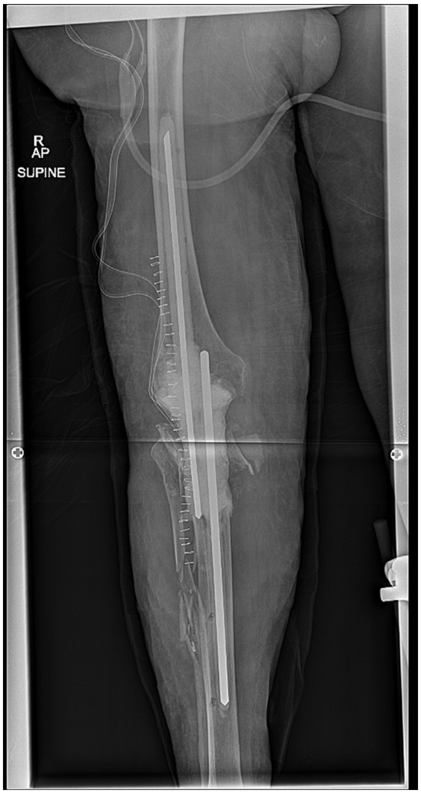

Figure 16. Case 6 preoperative radiograph. Image shows interval removal of prior external fixator, distal femoral component, and proximal tibial spacer and placement of static spacer composed of Rush rods and cement.

and pain relief. However, functional outcomes varied based on the extensor mechanism status, with most having some degree of extensor lag. PTR represents an opportunity for limb salvage in dire clinical scenarios with massive proximal tibial bone loss.

There are concerns regarding the longevity of PTR relative to DFR. Excluding patients who required revision for tumor recurrence, Biau et al. [11] reported median prosthetic survival of 130 months (95% confidence interval: 94.3 months to infinity) after DFR and 117 months (95% confidence interval: 101 months to infinity) after PTR. After 5 and 10 years, the survival rates were 85% and 55% after DFR and 72% and 43% after PTR, respectively [11]. Wunder et al. [24] reported 5-year prosthetic survival of 90% after treatment of distal femoral tumors and 69% after treatment of proximal tibial tumors.

There may be several reasons why PTR has particularly poor longevity. The proximal tibia has poor soft-tissue coverage, limited vascularity, and few local flap options [25,26]. Henderson et al. [27] found PTR to have the highest failure rates of all megaprostheses, with infection as the leading cause at 16%. Our series had no failures due to infection. It is critical to ensure adequate tissue coverage during closure to prevent infection and enable healing, which may necessitate a flap as in 2 of our cases. Furthermore, PTRs have high rates of extensor mechanism dysfunction. Biau et al. [11] reported on 35 patients with a tibial tumor, and 9 (26%) of them had failure of the reconstructed extensor mechanism. Bone-to-bone repair is often not an option, and thus, we rely on attempted soft-tissue repair, osteointegration of the tubercle fragment with the prosthesis, or allograft reconstruction to preserve extensor function, with limited success. Five of our 6 cases resulted in varying degrees of extensor lag. In the 2 cases that achieved near-full-active extension, the tibial tubercle was preserved and demonstrated healing of the diaphyseal bone. In PTR for non-oncologic indications, where en bloc resection is not required, we recommend preserving the anterolateral column of proximal tibia including the tubercle when possible to optimize extension mechanism function, which was the greatest challenge of this reconstruction in our series. Considering the functional consequences of extensor mechanism dysfunction, limb salvage with PTR must be an option weighed against knee fusion and amputation.

Because of wound and extensor mechanism concerns, it is prudent to immobilize the knee for some time after operation. We

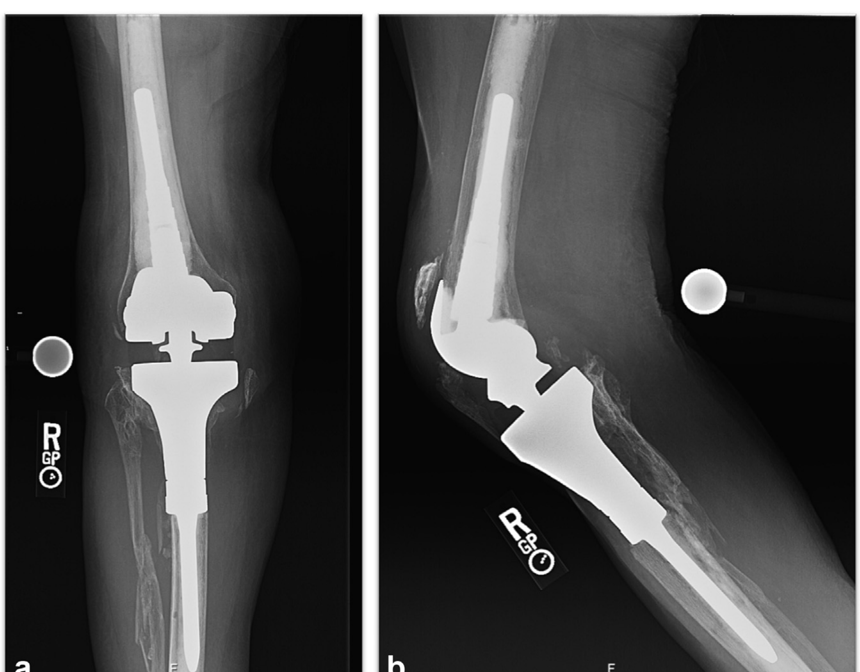

Figure 17. Case 6 at 3 mo postoperative. Left to right: (a, b) Anteroposterior and lateral radiographs show cemented long-stemmed femoral component and cemented proximal tibial replacement. Note patella alta on lateral radiograph (b).

prefer 2 or more weeks, although the ideal duration is unknown and longer immobilization or consideration of postoperative long leg casting may be advisable depending on the extensor mechanism reconstruction.

Acknowledging the potential complications associated with PTR, it remains an option for limb salvage outside of oncologic indications. Without malignant recurrence and radiation-induced complications, it is likely survivorship of PTR prostheses for non-oncologic indications will be superior to the survivorship reported in the oncology literature. Long-term follow-up of such cases is needed. In the current series, PTR was a reliable limb salvage procedure, and despite high rates of functional deficits, all patients achieved significant pain relief.

Summary

PTR is an available tool for limb salvage in complex joint arthroplasty for non-oncologic indications.

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